Lateef Kareem, Dept. Mechanical & Aerospace Engineering, West Virginia University, Morgantown, WV, 26506, and V'yacheslav Akkerman, Dept. Mechanical & Aerospace Engineering, West Virginia University, Morgantown, WV 26506. An alternative approach to describe flame acceleration in micro-tubes due to wall friction.

Among various existing analytical models proposed to describe flame acceleration (FA) and deflagration-to-detonation transition (DDT), none accounts for all distinctive stages of the FA and DDT processes. To overcome such a gap, here we propose an alternative model, which is based on the first physical principles and agrees with the experimental finding that FA is subsequently replaced by steady flame propagation. Starting with the Navier-stokes equation for an axial flow in a cylindrical tube, we set the pressure gradient to be proportional to the radial component of a velocity function and then absorbed the driving force into the temporal component of the resulting velocity differential equation. This leads to a model with two unknown parameters (coming from the temporal and radial component of the velocity function). Since the chemistry of the combustion is not considered in the model, these two parameters were computed by nonlinear fitting of the model to the experimental measurement showing good agreement between the model and the experiments.